

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P017376WO MJH	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/PEA/416)	
International application No. PCT/GB2004/001877	International filing date (<i>day/month/year</i>) 30.04.2004	Priority date (<i>day/month/year</i>) 10.06.2003
International Patent Classification (IPC) or both national classification and IPC G01V3/12		
Applicant OHM LIMITED et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 7 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 2 sheets.

3. This report contains indications relating to the following items:

I ☒ Basis of the opinion

II ☐ Priority

III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

IV ☐ Lack of unity of invention

V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

VI ☐ Certain documents cited

VII ☐ Certain defects in the international application

VIII ☐ Certain observations on the international application

Date of submission of the demand 07.01.2005	Date of completion of this report 02.06.2005
Name and mailing address of the international preliminary examining authority: <div style="display: flex; align-items: center;"> <div> European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016 </div> </div>	Authorized Officer Lorne, B Telephone No. +31 70 340-1002



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International application No. PCT/GB2004/001877

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, Pages

1-11, 13-29 as originally filed
12 received on 07.01.2005 with letter of 05.01.2005

Claims, Numbers

1-11, 13-19 as originally filed
12 received on 07.01.2005 with letter of 05.01.2005

Drawings, Sheets

1/5-5/5 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
☐ the language of publication of the international application (under Rule 48.3(b)).
☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
☐ filed together with the international application in computer readable form.
☐ furnished subsequently to this Authority in written form.
☐ furnished subsequently to this Authority in computer readable form.
☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

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5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	1-19
	No: Claims	
Inventive step (IS)	Yes: Claims	1-19
	No: Claims	
Industrial applicability (IA)	Yes: Claims	1-19
	No: Claims	

2. Citations and explanations

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Re Item V.

1 The following documents are referred to in this communication:

D1 : US 2003/048105 A1 (WESTERDAHL HARALD ET AL) 13 March 2003
(2003-03-13)

D2 : US 5 955 884 A (TABAROVSKY LEONTY A ET AL) 21 September 1999
(1999-09-21)

D3 : US-A-5 905 657 (CELNIKER GEORGE WILLIAM) 18 May 1999 (1999-05-18)

2. INDEPENDENT CLAIM 1

Document D1, which is considered to represent the most relevant state of the art, discloses (the references in parenthesis applying to this document) a method of analysing results from an electromagnetic survey of an area that is thought or known to contain a subterranean reservoir (paragraph 14) comprising the following steps:

- providing horizontal electric dipole (HED) response data obtained by at least one HED detector (paragraph 38) detecting a signal from a vertical electric dipole (VED) transmitter (paragraphs 31,38);
- providing background data specific to the area being surveyed (paragraph 37);
- comparing the response data with the background data to obtain difference data sensitive to the presence of a subterranean hydrocarbon reservoir (claim 1).

From this, the subject-matter of independent claim 1 differs in that the detector is orientated vertically and the transmitter is orientated horizontally.

The subject-matter of claim 1 is therefore novel (Article 33(2) PCT). The problem to be solved by the present invention may be regarded as a desire to perform surveys in shallow water with detectors which are not sensitive to airwave components.

The solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step (Article 33(3) PCT) for the following reasons.

In document D2 refracted airwaves are removed by subtraction between time-lapse surveys but the detectors are sensitive to the airwaves. Therefore, this method is less accurate since experimental conditions are difficult to reproduce from one survey to a second survey. In document D1, a horizontal electric dipole transmitter (E_x) and a vertical dipole receiver (E_z) are used in a multi-axis module. However, the problem to be solved is different and the vertical component (E_z) is not analysed in response to the signal transmitted by the horizontal electric dipole in order to obtain difference data sensitive to the presence of a subterranean hydrocarbon reservoir.

Claims 2-9 are dependent on claim 1 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

3. INDEPENDENT CLAIMS 10,11

These claims refer to a computer program and computer apparatus loaded with instructions for implementing the method of claim 1. Therefore, claims 10,11 meet the requirements of the PCT with respect to novelty and inventive step.

4. INDEPENDENT CLAIM 12

Document D2 discloses (the references in parenthesis applying to this document) an electromagnetic survey method for an area that is thought or known to contain a subterranean hydrocarbon reservoir (column 1, lines 14-16) comprising the following steps:

- deploying a horizontal electric dipole (HED) transmitter (fig.4) and at least one receiver, the receiver including a vertical electric dipole (VED) detector (fig.5);
- collecting from the at least one VED detector VED response data induced by the HED transmitter.

Remark : the VED detector (E_z) measures the current induced by the HED transmitter (E_x or E_y)

From this, the subject-matter of independent claim 1 differs in that the transmitter and the receiver are deployed at or above the seafloor.

The subject-matter of claim 12 is therefore novel (Article 33(2) PCT).

Document D2 is exclusively concerned with borehole logging which can investigate to greater radial distances surrounding a borehole and the problem of reducing the sensitivity of the electromagnetic survey to the airwave component is not disclosed in this document. The skilled man would not look to adapt the device of document D2 at or above seafloor surveying because the electromagnetic propagation mechanisms are different. Especially, the skilled man would not consider adapting the vertical electric dipole of the borehole disclosed in D2 for use at or above the seafloor because it would only serve to provide weaker signals than would be obtained with conventional horizontal dipole detectors employed for at or above seafloor surveying.

Therefore claim 12 is inventive.

Dependent claims 13-15 are dependent on claim 12 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

4. INDEPENDENT CLAIM 16

Document D3, which is considered to represent the most relevant state of the art, discloses (the references in parenthesis applying to this document) a method of planning an electromagnetic survey of an area that is thought or known to contain a subterranean reservoir (column 4, lines 4-7; lines 44-48) comprising the following steps:

- creating a model of the area to be surveyed with geological data and material properties
- adjusting the model to reduce the difference between the synthetic data and the acquired data.

From this, the subject-matter of independent claim 16 differs in that the vertical electric dipole response data is calculated for a signal emitted by a simulated horizontal electric dipole and in that the background data for comparison with the VED response data is obtained by adjusting the model to remove the postulated hydrocarbon reservoir.

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The subject-matter of claim 16 is therefore novel (Article 33(2) PCT).

The problem to be solved by the present invention may be regarded as selecting optimum surveying conditions in terms of the transmitter-to-detector distance and the frequency of EM signal.

The solution to this problem proposed in claim 16 of the present application is considered as involving an inventive step (Article 33(3) PCT) since the comparison between the VED response data and simulated background data is neither known from, nor rendered obvious by, the available prior art.

For the same reasons, the corresponding computer program and apparatus claims 18 and 19 are new and involves an inventive step (Article 33(2)(3) PCT).

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configuration. Background data may be obtained by modelling the EM survey performed to obtain the VED response data with a model background subterranean strata configuration. The background model strata configuration should preferably be a close match to the actual background structure in the area being surveyed.

5 The background data may be obtained in several ways, for example from a controlled source electromagnetic survey, from a magneto-telluric electromagnetic survey, from another similar survey taken at a different time, or from a rock formation model. If a rock formation model is used it should preferably include resistivity, and may be derived from a combination of geological data and resistivity data. The
10 geological data can be from seismological surveying and the resistivity data from well logging. Other sources of information, such as neutron data or other porosity estimates from well logs, could also be used.

 The difference data may represent the difference between the VED response data and the background data as a function of position within the area, and the
15 analysis may include identifying a location of a boundary of a subterranean hydrocarbon reservoir.

 According to a second aspect of the invention there is provided a computer program product bearing machine readable instructions for implementing a method of analysing results from an electromagnetic survey according to the first aspect of the
20 invention.

 According to a third aspect of the invention there is provided a computer apparatus loaded with machine readable instructions for implementing the method of analysing results from an electromagnetic survey according to the first aspect of the invention.

25 According to a fourth aspect of the invention there is provided an electromagnetic survey method applied to an area that is thought or known to contain a subterranean hydrocarbon reservoir, the area comprising subterranean strata beneath a seafloor, the method comprising: deploying at or above the seafloor a horizontal electric dipole (HED) transmitter and at least one receiver, the receiver including a vertical

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7. A method of analysing results from an electromagnetic survey according to claim 6, wherein the geological data are from seismological surveying.
8. A method of analysing results from an electromagnetic survey according to claim 6 or 7, wherein the resistivity data are from well logging.
9. A method of analysing results from an electromagnetic survey according to any one of claims 1 to 8, wherein difference data are obtained as a function of position within the area and are sensitive to boundaries of the subterranean hydrocarbon reservoir.
10. A computer program product bearing machine readable instructions for implementing a method of analysing results from an electromagnetic survey according to any one of any one of claims 1 to 9.
11. A computer apparatus loaded with machine readable instructions for implementing the method of analysing results from an electromagnetic survey according to any one of claims 1 to 9.
12. An electromagnetic survey method applied to an area that is thought or known to contain a subterranean hydrocarbon reservoir, the area comprising subterranean strata beneath a seafloor, the method comprising:
deploying at or above the seafloor a horizontal electric dipole (HED) transmitter and at least one receiver, the receiver including a vertical electric dipole (VED) detector; and
collecting from the at least one VED detector VED response data induced by the HED transmitter.
13. An electromagnetic survey method according to claim 12, wherein the receiver comprises a single vertically aligned antenna.